Measurement of the Gamow-Teller Branching Ratio in ^{14}O

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The Cabibbo-Kobayashi-Maskawa (CKM) matrix describes the mixing between the generations of quarks via the weak interaction. The CKM matrix should be unitary. If it is not, then there could be an undiscovered fourth generation of quarks. One unitarity test involves the first row of the matrix, in which the dominant term is the up-down coupling constant (Vud). This element is determined from precise measurements of superallowed Fermi beta decays. To Vud, one must measure the Q value, half-life, and branching ratio of a superallowed decay.

One such transition is the ^{14}O isotope (Figure 1). The half-life of is approximately 70.6 seconds. The ^{14}O is produced by the $^{12}C(^{3}He,n)^{14}O$ reaction at the 88" Cyclotron. We are also undertaking a precise measurement of the half-life. The Q-value has been recently re-measured to be 10 standard deviations different from the previous result [1]. The branching ratio of the Fermi decay is 99.4%, with the remainder feeding a 0.61% Gamow-Teller transition, see figure below. The superallowed branching ratio is inferred by subtracting the Gamow-Teller amplitude, which has been measured only once at sufficiently high precision[2].

We have measured the branching ratio by using a flat-field magnetic spectrometer with a multi-wire proportional chamber. The acceptance of the spectrometer is roughly 10^{-4}. To measure the Gamow-Teller amplitude to 1% fractional uncertainty, we require a point source of ^{14}O of at least 10^{7} atoms for approximately 48 hours. This can be accomplished using the Ion Source for Radioactive ISotopes (IRIS ECR) at the 88" Cyclotron. The ion beam travels through an analyzing magnet for isotopic selection. The ^{14}O is focused and embedded into a thin beryllium foil, forming a 6 mm diameter source for the experiment.

During 2001, the beta spectrometer and proportional wire chamber detector were moved to the experimental area. The spectrometer was coupled with the IRIS test stand. The first data run was performed on November 20, 2002. The experiment was repeated in January 2003 with improved radiation shielding installed. The branching ratio can be determined to ~1% fractional statistical uncertainty. Analysis is still in progress, focusing on systematic errors associated with geometry, background, and wire chamber position response.

Footnotes

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References

1. Tolich N.R. Et al., Phys. Rev. C 67, 035503 (2003)

2. G.S. Sidhu et al., Phys. Rev. 148, 1024 (1966).

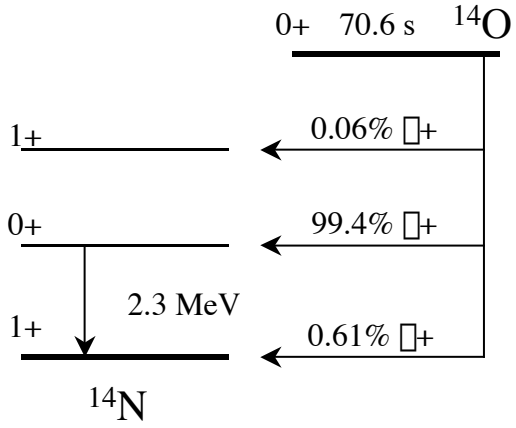

Fig. 1. ^{14}O decay scheme